US009127865B2

(12) **United States Patent**
Choi et al.

(10) **Patent No.: US 9,127,865 B2**
(45) **Date of Patent: Sep. 8, 2015**

(54) **AIR CONDITIONING SYSTEM INCLUDING A BYPASS PIPE**

(75) Inventors: **Song Choi**, Seoul (KR); **Yun Ho Ryu**, Seoul (KR); **Baik Young Chung**, Seoul (KR); **Kyung Won Seo**, Seoul (KR)

(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1229 days.

(21) Appl. No.: **12/453,215**

(22) Filed: **May 1, 2009**

(65) **Prior Publication Data**

US 2010/0051229 A1 Mar. 4, 2010

(30) **Foreign Application Priority Data**

Aug. 27, 2008 (KR) 10-2008-0083629

(51) **Int. Cl.**

F25B 29/00	(2006.01)
F25B 13/00	(2006.01)
F25B 41/04	(2006.01)

(52) **U.S. Cl.**

CPC ***F25B 13/00*** (2013.01); ***F25B 41/04*** (2013.01); *F25B 2313/008* (2013.01); *F25B 2313/0233* (2013.01); *F25B 2313/02741* (2013.01); *F25B 2341/066* (2013.01); *F25B 2400/04* (2013.01); *F25B 2400/19* (2013.01)

(58) **Field of Classification Search**

CPC F25D 31/005; F25B 27/00; F24F 3/10; F24F 3/08; F24F 3/06; F24F 3/065; F24F 11/08; F24D 10/006; F24D 19/1021

USPC 165/61, 62, 63, 220, 221

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,268,048	A	*	12/1941	McElgin	236/37
3,188,829	A	*	6/1965	Siewert et al.	62/160
3,195,622	A	*	7/1965	Greene, Jr. et al.	165/101
3,308,877	A	*	3/1967	Gerteis	165/62
3,378,062	A	*	4/1968	Ringquist et al.	165/221
4,012,920	A	*	3/1977	Kirschbaum	62/235.1
4,018,581	A	*	4/1977	Ruff et al.	62/235.1
4,067,383	A	*	1/1978	Padden	165/247
4,098,092	A	*	7/1978	Singh	62/238.6
4,100,755	A	*	7/1978	Leonard	62/238.3
4,111,259	A	*	9/1978	Lebduska	62/235.1
4,165,037	A		8/1979	McCarson	
4,179,894	A	*	12/1979	Hughes	62/79
4,187,687	A	*	2/1980	Savage	62/238.2
4,228,846	A	*	10/1980	Smorol	165/240
4,256,475	A	*	3/1981	Schafer	62/235.1
4,257,238	A	*	3/1981	Kountz et al.	62/228.1
4,313,307	A	*	2/1982	Sisk	62/79
4,336,692	A	*	6/1982	Ecker et al.	62/235.1
4,353,409	A	*	10/1982	Saunders et al.	165/240

(Continued)

FOREIGN PATENT DOCUMENTS

CN	1205073	1/1999
CN	1311210 C	7/2005

(Continued)

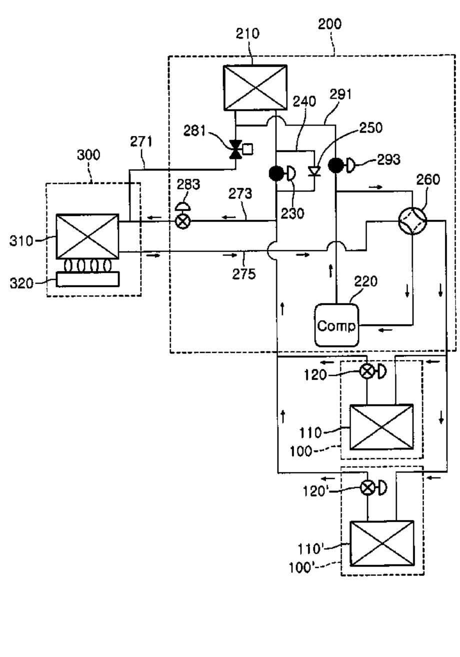
Primary Examiner — Ljiljana Ciric

(74) *Attorney, Agent, or Firm* — Dentons US LLP

(57) **ABSTRACT**

An air conditioning system includes a compressor, an outdoor heat exchanger that discharges evaporated refrigerant, and a first pipe coupling the outdoor heat exchanger and the compressor, where the first pipe allows the outdoor heat exchanger to receive at least a portion of the compressed refrigerant from the compressor.

14 Claims, 5 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

4,441,331	A *	4/1984	Yuyama	62/196.3
4,441,901	A *	4/1984	Endoh	62/238.7
4,516,408	A *	5/1985	Chiba	62/238.7
4,614,090	A *	9/1986	Kaneko et al.	62/158
4,644,756	A *	2/1987	Sugimoto et al.	62/160
4,645,908	A *	2/1987	Jones	165/63
4,693,089	A *	9/1987	Bourne et al.	62/238.6
4,787,444	A *	11/1988	Countryman	165/48.2
4,869,074	A *	9/1989	Hoshi et al.	62/238.7
4,876,856	A *	10/1989	Iishiki et al.	62/238.4
4,878,357	A *	11/1989	Sekigami et al.	62/228.4
4,920,750	A *	5/1990	Iishiki et al.	60/671
4,987,747	A *	1/1991	Nakamura et al.	62/324.6
5,029,449	A *	7/1991	Wilkinson	62/175
5,063,752	A *	11/1991	Nakamura et al.	62/324.6
5,107,684	A *	4/1992	Nakayama et al.	62/324.6
5,142,879	A *	9/1992	Nakamura et al.	62/324.6
5,156,014	A *	10/1992	Nakamura et al.	62/160
5,159,817	A *	11/1992	Hojo et al.	62/81
5,161,388	A *	11/1992	Fujita et al.	62/175
5,163,503	A *	11/1992	Inoue	165/231
5,237,833	A *	8/1993	Hayashida et al.	62/324.6
5,239,838	A *	8/1993	Tressler	62/235.1
5,263,333	A *	11/1993	Kubo et al.	62/160
5,272,885	A *	12/1993	Watanabe	62/184
5,277,034	A *	1/1994	Hojo et al.	62/160
5,297,392	A *	3/1994	Takata et al.	62/160
5,309,728	A *	5/1994	Chae	62/158
5,309,733	A *	5/1994	Hayashida et al.	62/278
5,320,166	A *	6/1994	Swenson	165/236
5,366,153	A *	11/1994	Swenson	165/236
5,370,307	A *	12/1994	Uehra	237/2 B
5,381,671	A *	1/1995	Saito et al.	62/430
5,388,422	A *	2/1995	Hayashida et al.	62/211
5,461,876	A *	10/1995	Dressler	62/238.7
5,526,649	A *	6/1996	Sada	62/175
5,548,968	A *	8/1996	Sada	62/175
5,628,200	A *	5/1997	Pendergrass	62/197
5,761,921	A *	6/1998	Hori et al.	62/238.4
5,878,810	A	3/1999	Saito et al.	
6,126,080	A *	10/2000	Wada	62/175
6,735,969	B2 *	5/2004	Kasagi et al.	62/238.7
6,883,345	B2 *	4/2005	Lee	62/324.6
7,243,505	B2 *	7/2007	Cho et al.	62/238.7
7,308,800	B2 *	12/2007	Park et al.	62/159
7,395,677	B2 *	7/2008	Fujiyoshi et al.	62/324.1
7,451,611	B2 *	11/2008	Muscatell	62/235.1
7,493,775	B2 *	2/2009	Shimamoto et al.	62/199
7,716,941	B2 *	5/2010	Park et al.	62/87
7,954,333	B2 *	6/2011	Yoshimi	62/129
7,984,620	B2 *	7/2011	Shimamoto et al.	62/324.1
8,001,802	B2 *	8/2011	Choi et al.	62/332
8,109,111	B2 *	2/2012	Yamada	62/324.1
8,220,280	B2 *	7/2012	Chang et al.	62/149
8,261,569	B2 *	9/2012	Choi et al.	62/324.6
8,281,614	B2 *	10/2012	Koo et al.	62/506
8,418,494	B2 *	4/2013	Shinozaki et al.	62/324.1
8,752,397	B2 *	6/2014	Yamashita et al.	62/151
2003/0014988	A1	1/2003	Watanabe et al.	
2003/0041609	A1 *	3/2003	Kasagi et al.	62/238.7
2003/0070445	A1 *	4/2003	Kasagi et al.	62/238.7
2006/0037346	A1 *	2/2006	Cho et al.	62/323.1
2006/0037352	A1 *	2/2006	Cho et al.	62/323.3
2006/0070719	A1 *	4/2006	Kim et al.	165/61
2006/0254294	A1 *	11/2006	Shimamoto et al.	62/238.7
2007/0012058	A1 *	1/2007	Cho et al.	62/238.7
2007/0180844	A1 *	8/2007	Fujiyoshi et al.	62/271
2008/0196432	A1 *	8/2008	Shimamoto et al.	62/238.7
2008/0271881	A1 *	11/2008	Blecker	165/254
2009/0255284	A1 *	10/2009	Yoshimi	62/149
2014/0230473	A1 *	8/2014	Yamashita et al.	62/156

FOREIGN PATENT DOCUMENTS

CN	1776325 A	5/2006
EP	1 645 817	4/2006
EP	1 647 783	4/2006
JP	08-166175	6/1996
JP	09-138024	5/1997
JP	2005-016805 A	1/2005
JP	2007-051820 A	3/2007

* cited by examiner

Fig. 1

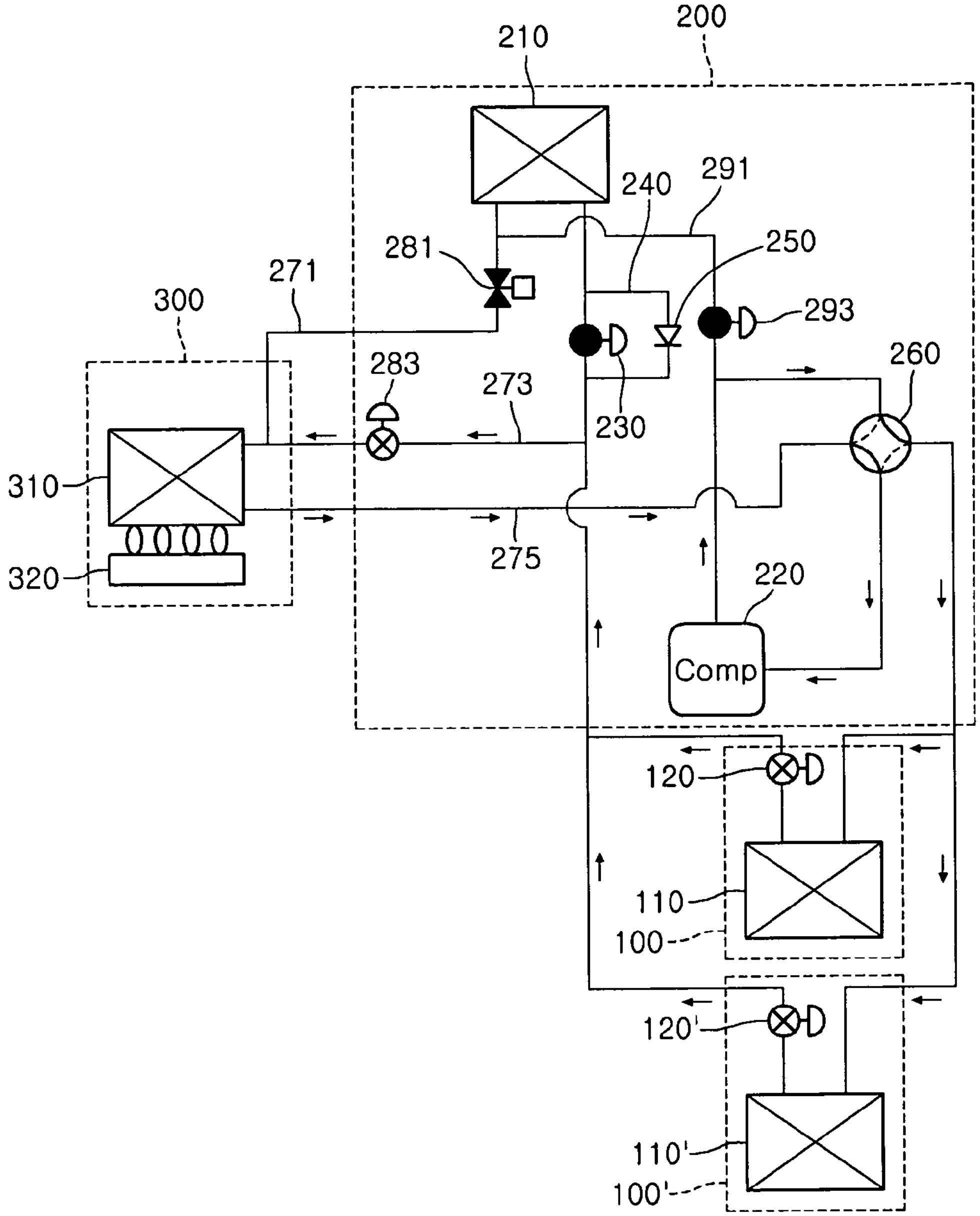

200
210
240
291
250
281
271
293
300
283
273
230
260
310
275
320
220
Comp
120
110
100
120'
110'
100'

Fig. 2

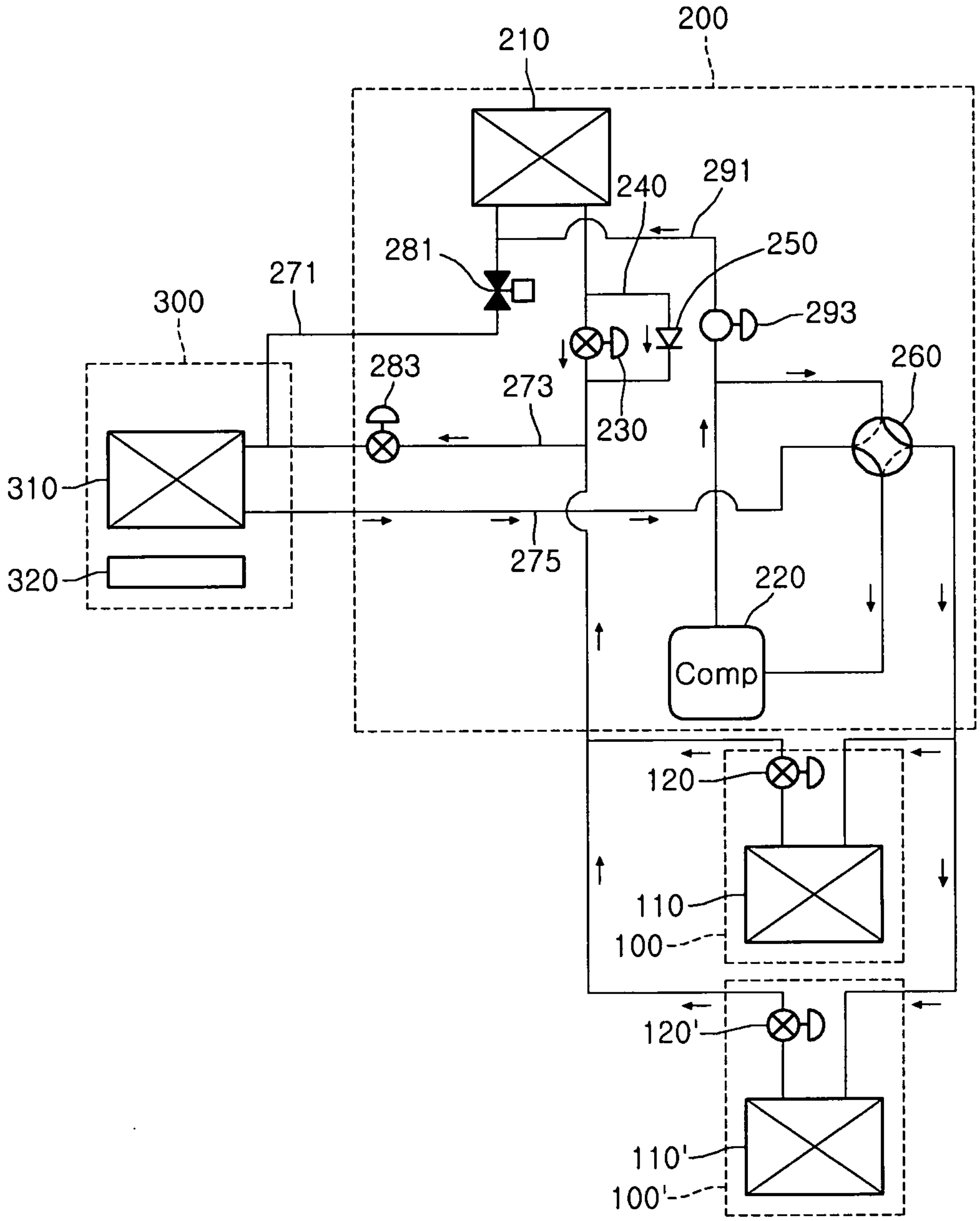

200
210
240
291
281
250
271
300
293
260
283
273
230
310
275
320
220
Comp
120
110
100
120'
110'
100'

Fig. 3

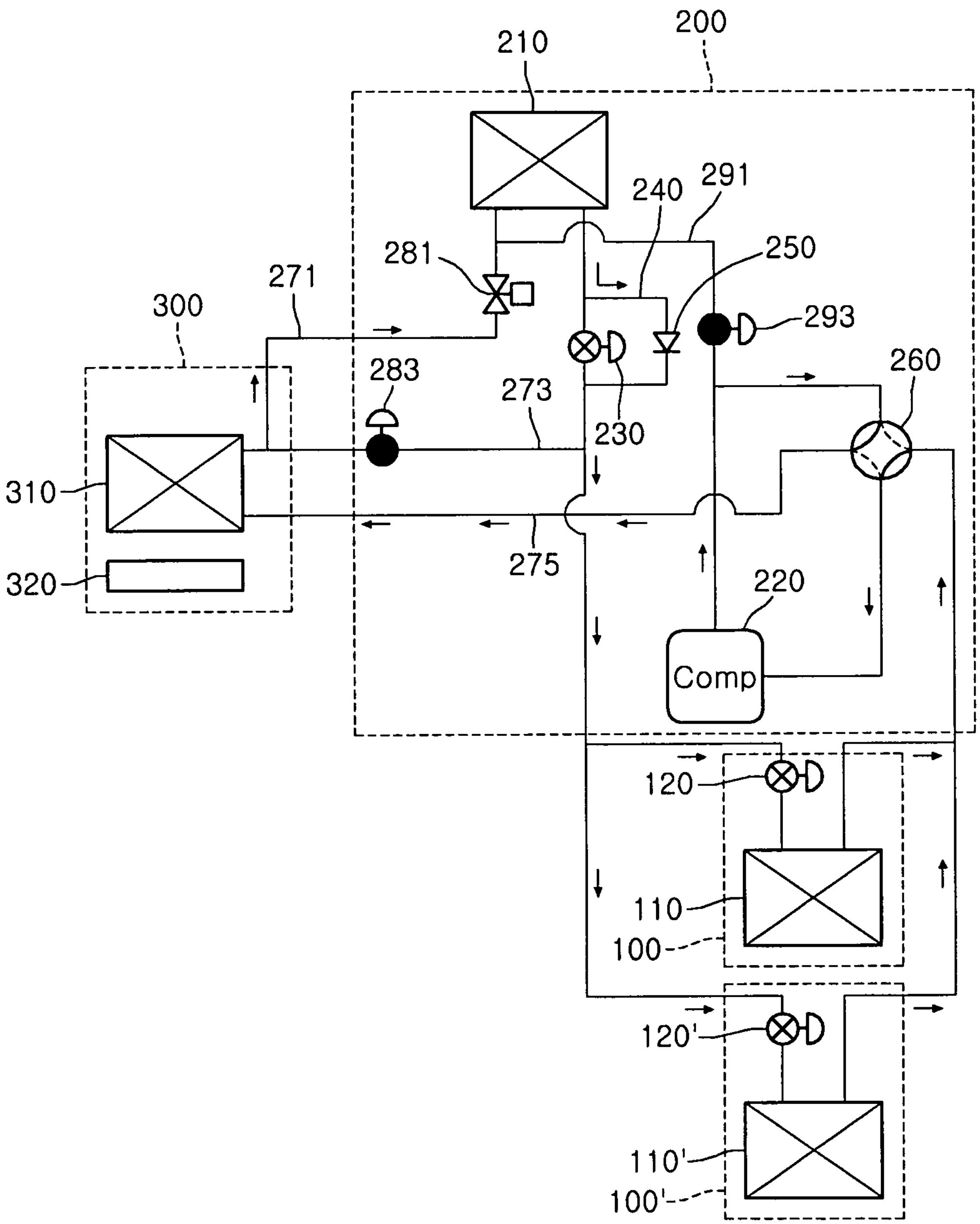

200
210
240
291
250
281
271
300
293
283
260
273
230
310
275
220
320
Comp
120
110
100
120'
110'
100'

Fig. 4

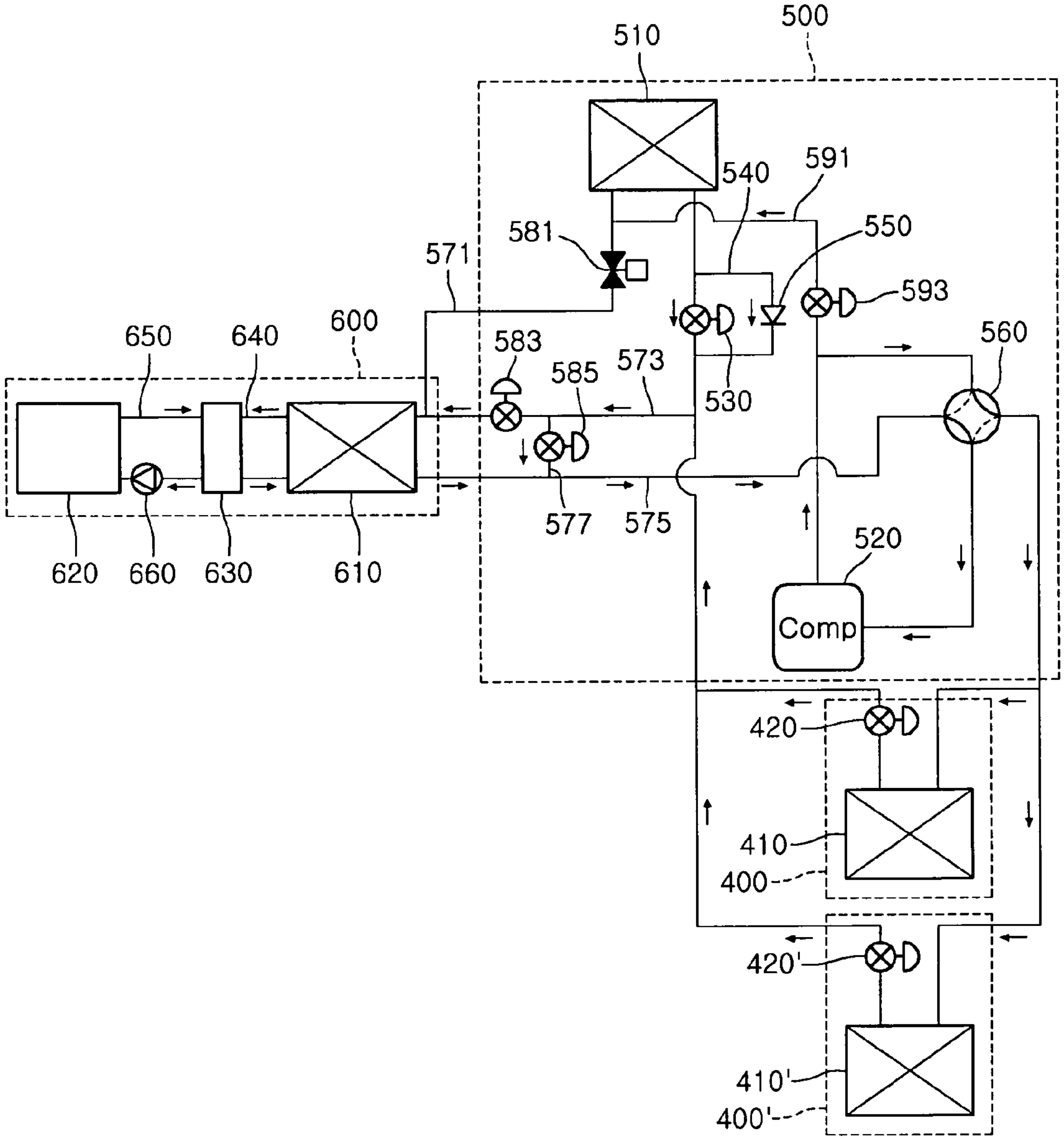
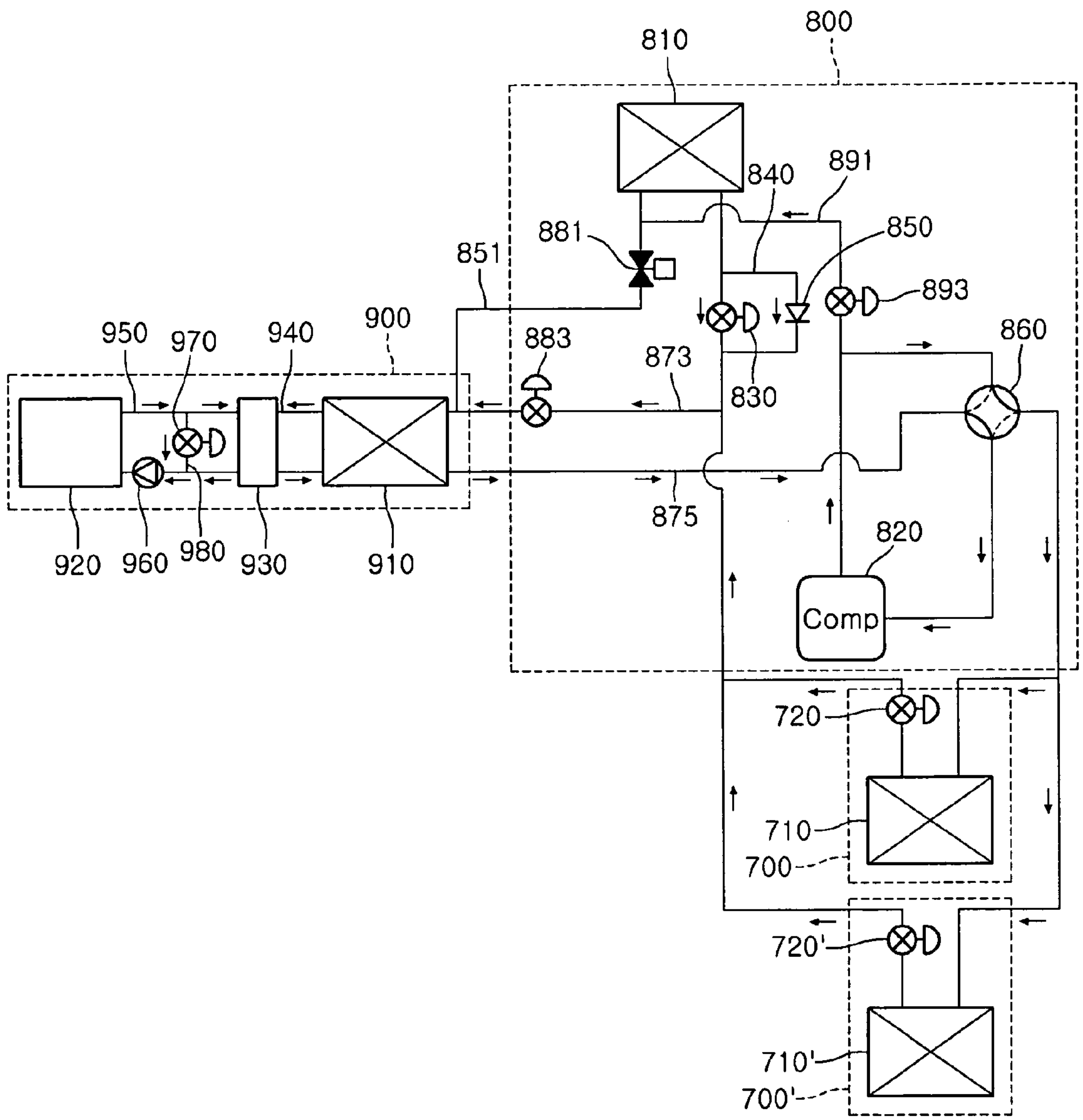

500
510
540
591
581
571
550
593
530
560
583
585
573
650
640
600
577
575
520
620
660
630
610
Comp
420
410
400
420'
410'
400'

Fig. 5


800
810
840
891
881
850
851
893
900
950
970
940
883
873
860
830
875
820
Comp
920
960
980
930
910
720
710
700
720'
710'
700'

AIR CONDITIONING SYSTEM INCLUDING A BYPASS PIPE

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority under 35 U.S.C. 119 and 35 U.S.C. 365 to Korean Patent Application No. 10-2008-0083629 (filed on Aug. 27, 2008), which is hereby incorporated by reference in its entirety.

BACKGROUND

The present disclosure relates to an air conditioning system, and more particularly, to an air conditioning system that can be used for both cooling and heating.

In general, an air conditioning system includes a compressor, a four-way valve, an indoor heat exchanger, and an outdoor heat exchanger that are used to perform heat exchange cycles for cooling or heating an indoor area. In heating mode, the outdoor heat exchanger is operated as an evaporator, and the indoor heat exchanger is operated as a condenser. In detail, indoor heating is performed as follows: while refrigerant is evaporated in the outdoor heat exchanger, heat is exchanged between the refrigerant and outdoor air; the refrigerant is then compressed to a high-temperature and high-pressure state by the compressor; and while the compressed refrigerant is condensed at the indoor heat exchanger, heat is exchanged between the refrigerant and indoor air.

A refrigerant heating device can be used to heat the refrigerant evaporated in the outdoor heat exchanger in heating mode. That is, in the case where refrigerant is not smoothly evaporated in the outdoor heat exchanger due to a very low outdoor temperature, the refrigerant is heated before the refrigerant is transferred to the compressor. In more detail, refrigerant condensed at the indoor heat exchanger is evaporated at the outdoor heat exchanger or heated by the refrigerant heating device, and the refrigerant is transferred to the compressor.

SUMMARY

Embodiments provide an air conditioning system in which refrigerant is not accumulated in an outdoor heat exchanger in heating mode.

In one embodiment, an air conditioning system includes a compressor; an outdoor heat exchanger that discharges evaporated refrigerant; and a first pipe coupling the outdoor heat exchanger and the compressor, where the first pipe allows the outdoor heat exchanger to receive at least a portion of the compressed refrigerant from the compressor.

In another embodiment, an air conditioning system includes an outdoor heat exchanger; a compressor; a heater; a first pipe coupling the outdoor heat exchanger and the heater; and a second pipe coupling the first pipe and the compressor.

According to the present disclosure, the air conditioning system can be operated more stably.

The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1** and **2** are views for illustrating flows of refrigerant in an air conditioning system when the air conditioning system is operated in heating mode according to a first embodiment.

FIG. **3** is a view for illustrating flows of refrigerant in the air conditioning system when the air conditioning system is operated in cooling mode according to the first embodiment.

FIG. **4** is view for illustrating flows of refrigerant in an air conditioning system when the air conditioning system is operated in heating mode according to a second embodiment.

FIG. **5** is a view for illustrating flows of refrigerant in heating mode according to a third embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENTS

An air conditioning system will now be described in more detail with reference to the accompanying drawings according to a first embodiment.

FIGS. **1** and **2** are views for illustrating flows of refrigerant in an air conditioning system when the air conditioning system is operated in heating mode according to a first embodiment, and FIG. **3** is a view for illustrating flows of refrigerant in the air conditioning system when the air conditioning system is operated in cooling mode according to the first embodiment.

Referring to FIGS. **1** to **3**, the air conditioning system is used to cool or heat an indoor area through heat exchange cycles in which refrigerant exchanges heat with indoor air and outdoor air. The air conditioning system includes a plurality of indoor units **100** and **100'**, and an outdoor unit **200**, and a refrigerant heating device **300**.

In more detail, the indoor units **100** and **100'** include indoor heat exchangers **110** and **110'**, respectively. The indoor heat exchangers **110** and **110'** are operated as condensers in heating mode and evaporators in cooling mode. That is, in heating mode, the indoor heat exchangers **110** and **110'** receive refrigerant compressed by a compressor **220** (described later) and condense the refrigerant. In cooling mode, the indoor heat exchangers **110** and **110'** receive refrigerant condensed by an outdoor heat exchanger **210** and evaporate the refrigerant.

The indoor units **100** and **100'** further include linear expansion valves (LEVs) **120** and **120'**, respectively. In cooling mode, the linear expansion valves **120** and **120'** of the indoor units **100** and **100'** are used to expand refrigerant evaporated by the indoor heat exchangers **110** and **110'**. In heating mode, the linear expansion valves **120** and **120'** of the indoor units **100** and **100'** are opened so that refrigerant can pass through the linear expansion valves **120** and **120'**.

The outdoor heat exchanger **210** is included in the outdoor unit **200**. The outdoor heat exchanger **210** is operated as an evaporator in heating mode and a condenser in cooling mode. In other words, in heating mode, the outdoor heat exchanger **210** evaporates refrigerant condensed by the indoor heat exchangers **110** and **110'** and transfers the evaporated refrigerant to the compressor **220**. In cooling mode, the outdoor heat exchanger **210** condenses refrigerant and transfers the condensed refrigerant to the indoor heat exchangers **110** and **110'**.

The compressor **220** is included in the outdoor unit **200**. The compressor **220** compresses refrigerant and discharges the compressed refrigerant to the indoor heat exchangers **110** and **110'** or the outdoor heat exchanger **210**. In more detail, the compressor **220** compresses refrigerant and discharges the compressed refrigerant to the indoor heat exchangers **110** and **110'** in heating mode and to the outdoor heat exchanger **210** in cooling mode.

The outdoor unit **200** further includes a linear expansion valve **230**. In heating mode, the linear expansion valve **230** of the outdoor unit **200** expands refrigerant condensed by the indoor heat exchangers **110** and **110'** and transfers the refrigerant to the outdoor heat exchanger **210**. In cooling mode, the linear expansion valve **230** of the outdoor unit **200** is closed, or the opening of the opened linear expansion valve **230** is adjusted.

The outdoor unit **200** further includes a parallel pipe **240** and a check valve **250**. The parallel pipe **240** is connected in parallel to a refrigerant pipe through which refrigerant flows to the outdoor heat exchanger **210** in heating mode. The check valve **250** is disposed at the parallel pipe **240**.

The outdoor unit **200** further includes a four-way valve **260**. The four-way valve **260** is disposed at refrigerant pipes through which refrigerant compressed by the compressor **220** flows. In heating mode, the four-way valve **260** is positioned in a manner such that refrigerant compressed by the compressor **220** can flow to the indoor heat exchangers **110** and **110'** and refrigerant evaporated by the outdoor heat exchanger **210** can flow to the compressor **220**. In cooling mode, the four-way valve **260** is positioned in a manner such that refrigerant compressed by the compressor **220** can be discharged to the outdoor heat exchanger **210** and refrigerant condensed by the outdoor heat exchanger **210** can be transferred to the indoor heat exchangers **110** and **110'**.

The outdoor unit **200** further includes first to third connection pipes **271**, **273**, and **275**. The first connection pipe **271** connects the outdoor heat exchanger **210** and the refrigerant heating device **300**. In heating mode, refrigerant evaporated by the outdoor heat exchanger **210** flows to the refrigerant heating device **300** through the first connection pipe **271**. The second connection pipe **273** connects the refrigerant heating device **300** to a refrigerant pipe connected from the indoor heat exchangers **110** and **110'** to the outdoor heat exchanger **210**. In heating mode, refrigerant condensed by the indoor heat exchangers **110** and **110'** flows to the refrigerant heating device **300** through the second connection pipe **273**. The third connection pipe **275** connects the compressor **220** and the refrigerant heating device **300**. In heating mode, refrigerant heated by the refrigerant heating device **300** flows to the compressor **220** through the third connection pipe **275**.

The outdoor unit **200** further includes first and second valves **281** and **283**. The first valve **281** is disposed at the first connection pipe **271**. In heating mode, the first valve **281** is closed if the refrigerant heating device **300** is used to heat refrigerant. The first valve **281** is opened in cooling mode or in heating mode if the refrigerant heating device **300** is not used. The second valve **283** is disposed at the second connection pipe **273**. The second valve **283** is opened in heating mode if the refrigerant heating device **300** is used to heat refrigerant. The second valve **283** is closed in cooling mode or in heating mode if the refrigerant heating device **300** is not used.

The outdoor unit **200** further includes a bypass pipe **291** and a third valve **293**. The bypass pipe **291** connects the first connection pipe **271** with a refrigerant pipe through which refrigerant discharged from the compressor **220** flows toward the indoor heat exchangers **110** and **110'** in heating mode. The bypass pipe **291** provides a flow path for refrigerant compressed by the compressor **220** and discharged toward the outdoor heat exchanger **210**. The third valve **293** is disposed at the bypass pipe **291**. The third valve **293** is opened when refrigerant accumulated in the outdoor heat exchanger **210** is re-circulated in a heat exchange cycle.

In heating mode, the refrigerant heating device **300** heats refrigerant evaporated by the outdoor heat exchanger **210**. For this, the refrigerant heating device **300** includes an auxiliary heat exchanger **310** and a heating unit **320**.

In more detail, refrigerant flows from the first connection pipe **271** or the second connection pipe **273** to the inside of the auxiliary heat exchanger **310**. The heating unit **320** heats the auxiliary heat exchanger **310** so that refrigerant flowing through the auxiliary heat exchanger **310** can be heated.

An exemplary operation of the air conditioning system will now be described in detail according to the first embodiment.

Referring to FIG. **1**, in a heating mode using the refrigerant heating device **300**, the linear expansion valve **230**, the first valve **281**, and the third valve **293** of the outdoor unit **200** are closed, and the second valves **283** of the outdoor unit **200** is opened. The heating unit **320** is operated to heat refrigerant flowing through the auxiliary heat exchanger **310**. Therefore, during a heat exchange cycle, refrigerant is heated by the refrigerant heating device **300** and then directed to the compressor **220**. At this time, the four-way valve **260** is in a heating-mode position.

In more detail, refrigerant compressed by the compressor **220** is discharged to the indoor heat exchangers **110** and **110'** through the four-way valve **260**. Then, at the indoor heat exchangers **110** and **110'**, the refrigerant exchanges heat with indoor air and condenses. Therefore, indoor areas can be heated.

Next, the refrigerant condensed at the indoor heat exchangers **110** and **110'** passes through the linear expansion valves **120** and **120'** of the indoor units **100** and **100'** and flows to the auxiliary heat exchanger **310** through the second connection pipe **273**. At this time, while the refrigerant flows in the second connection pipe **273** toward the auxiliary heat exchanger **310**, the refrigerant expands at the second valve **283**. Then, the refrigerant reaches the auxiliary heat exchanger **310** where the refrigerant is heated by the heating unit **320** and is discharged to the third connection pipe **275**. The refrigerant flows from the third connection pipe **275** to the compressor **220**, thereby completing one cycle of heat exchange. At this time, since the third valve **293** is in a closed state, the refrigerant compressed at the compressor **220** is not discharged to the outdoor heat exchanger **210** through the bypass pipe **291**. Furthermore, owing to the check valve **250**, the refrigerant compressed at the compressor **220** is not discharged to the outdoor heat exchanger **210** through the parallel pipe **240**.

Referring to FIG. **2**, in a heating mode using the refrigerant heating device **300**, the opened linear expansion valve **230**, the second valve **283**, and the third valve **293** of the outdoor unit **200** are opened, and the first valve **281** of the outdoor unit **200** is closed. Therefore, some of refrigerant compressed by the compressor **220** is discharged to the outdoor heat exchanger **210** through the bypass pipe **291**.

In more detail, refrigerant compressed by the compressor **220** is discharged to the indoor heat exchangers **110** and **110'** where the refrigerant is condensed. The refrigerant condensed at the indoor heat exchangers **110** and **110'** is transferred to the auxiliary heat exchanger **310** and heated by the heating unit **320**. Then, the refrigerant is sucked by the compressor **220**.

Meanwhile, some of the refrigerant compressed by the compressor **220** is transferred to the first connection pipe **271** through the bypass pipe **291**. At this time, since the first valve **281** is closed, the refrigerant transferred to the first connection pipe **271** is directed to the outdoor heat exchanger **210**. Since the opened linear expansion valve **230** of the outdoor unit **200** is opened, the refrigerant, together with refrigerant accumulated in the outdoor heat exchanger **210**, flows from the outdoor heat exchanger **210** to a refrigerant pipe connected from the outdoor heat exchanger **210** to the indoor heat exchangers **110** and **110'** and to the parallel pipe **240** where the check valve **250** is disposed. However, refrigerant condensed at the indoor heat exchangers **110** and **110'** flows toward the outdoor heat exchanger **210** through the refrigerant pipe connected from the outdoor heat exchanger **210** to the indoor heat exchangers **110** and **110'**. Therefore, the refrigerant transferred to the outdoor heat exchanger **210** through the bypass pipe **291** and the first connection pipe **271**, and the refrigerant accumulated in the outdoor heat exchanger **210** are transferred to the auxiliary heat exchanger **310** through the second connection pipe **273** after they flow along some length of the refrigerant pipe connected from the outdoor heat exchanger **210** to the indoor heat exchangers **110** and **110'**. Then, the refrigerant transferred to the auxiliary heat exchanger **310** is heated by the heating unit **320** and sucked by the compressor **220**.

Refrigerant accumulated in the outdoor heat exchanger **210** may be re-circulated in this way when insufficient refrigerant circulates in a heat exchange cycle. For example, when the temperature of refrigerant discharged from the compressor **220** is equal to or higher than a reference temperature, it may be determined that the amount of refrigerant circulating in the heat exchange cycle is insufficient.

Referring to FIG. **3**, in cooling mode, the opening of the linear expansion valve **230** is adjusted, and the first valve **281** is opened but the second and third valves **283** and **293** are closed. The heating unit **320** is not operated such that refrigerant flowing through the auxiliary heat exchanger **310** is not heated. That is, during heat exchange cycles, refrigerant is not heated by the refrigerant heating device **300**. The four-way valve **260** is shifted to a cooling-mode position.

In more detail, refrigerant compressed by the compressor **220** is discharged to the outdoor heat exchanger **210**. At the outdoor heat exchanger **210**, the refrigerant is condensed by heat exchange with outdoor air.

The refrigerant condensed at the outdoor heat exchanger **210** is transferred to the indoor heat exchangers **110** and **110'**. While the refrigerant is transferred from the outdoor heat exchanger **210** to the indoor heat exchangers **110** and **110'**, the refrigerant is expanded by the linear expansion valves **120** and **120'** of the indoor units **100** and **100'**.

At the indoor heat exchangers **110** and **110'**, the refrigerant is evaporated by heat exchange with indoor air. Therefore, the indoor areas can be cooled by heat exchange between the indoor air and the refrigerant at the indoor heat exchangers **110** and **110'**.

After the heat exchange, the refrigerant is transferred from the indoor heat exchangers **110** and **110'** to the compressor **220** through the four-way valve **260**. The compressor **220** compresses the refrigerant and discharges the compressed refrigerant to the auxiliary heat exchanger **310**. At this time, since the heating unit **320** is not operated, the refrigerant discharged to the auxiliary heat exchanger **310** is not heated by the heating unit **320**.

Meanwhile, since the first valve **281** is opened, the refrigerant is discharged from the auxiliary heat exchanger **310** to the outdoor heat exchanger **210** through the first connection pipe **271**. At the outdoor heat exchanger **210**, the refrigerant is condensed by heat exchange with outdoor air. The condensed refrigerant is transferred to the indoor heat exchangers **110** and **110'** through the refrigerant pipe connected from the outdoor heat exchanger **210** to the indoor heat exchangers **110** and **110'**, and the parallel pipe **240** connected in parallel to the refrigerant pipe.

An air conditioning system will now be described in detail with reference to the accompanying drawing according to a second embodiment.

FIG. **4** is view for illustrating flows of refrigerant in an air conditioning system when the air conditioning system is operated in heating mode according to a second embodiment. In the current embodiment, similar elements as those in the first embodiment will not be described in detail.

Referring to FIG. **4**, in the current embodiment, a outdoor unit **200** includes a bypass pipe **577** (hereinafter, referred to as a second bypass pipe to distinguish it from a bypass pipe **591**) and a fourth valve **585**. The second bypass pipe **577** is connected between second and third connection pipe **573** and **575**. In heating mode, some of refrigerant condensed at indoor heat exchangers **410** and **410'** and transferred to a refrigerant heating device **600** is bypassed through the second bypass pipe **577**. That is, some of refrigerant flowing through the second connection pipe **573** is bypassed to the third connection pipe **575** through the second bypass pipe **577**. In heating mode, the fourth valve **585** is opened if the refrigerant heating device **600** is used to heat refrigerant and is closed if the refrigerant heating device **600** is not used to heat refrigerant. In addition, the fourth valve **585** is closed in cooling mode.

The opened areas of a second valve **583** and the fourth valve **585** are adjusted according to the heating load of indoor area. In more detail, if the second valve **583** is less opened and the fourth valve **585** is more opened, the amount of refrigerant bypassed through the bypass pipe **577** is increased. On the other hand, if the second valve **583** is more opened and the fourth valve **585** is less opened, the amount of refrigerant bypassed through the bypass pipe **577** is decreased.

Referring to FIG. **4**, in the current embodiment, a refrigerant heating device **600** includes an auxiliary heat exchanger **610**, a heating unit **620**, a heat exchange unit **630**, a heating pipe **640**, a fluid pipe **650**, and a pump **660**. During a heat exchange cycle, refrigerant is transferred to the auxiliary heat exchanger **610**. The heating unit **620** heats a working fluid. At the heat exchange unit **630**, the refrigerant transferred to the auxiliary heat exchanger **610** exchanges heat with the working fluid heated by the heating unit **620**. The refrigerant transferred to the auxiliary heat exchanger **610** flows through the heating pipe **640**, and the working fluid heated by the heating unit **620** circulates through the fluid pipe **650**. That is, substantially at the heat exchange unit **630**, heat exchange occurs between the refrigerant flowing through the heating pipe **640** and the working fluid circulating through the fluid pipe **650**. The pump **660** forces the working fluid to circuit through the fluid pipe **650**.

In the current embodiment, other elements of the air conditioning system, such as an indoor heat exchanger **410** and a linear expansion valve **420** of an indoor unit **400**, an outdoor heat exchanger **510** of an outdoor unit **500**, a compressor **520**, a linear expansion valve **530**, a parallel pipe **540**, a check valve **550**, a four-way valve **560**, first to third connection pipes **571**, **573**, and **575**, first and second valves **581** and **583**, the bypass pipe **591**, and a third valve **593**, have similar structures as those of the air conditioning system of the first embodiment. Thus, detailed descriptions thereof will be omitted.

An air conditioning system will now be described in detail with reference to the accompanying drawing according to a third embodiment.

FIG. **5** is view for illustrating flows of refrigerant in an air conditioning system when the air conditioning system is operated in heating mode according to a third embodiment. In the current embodiment, similar elements as those in the first embodiment and/or the second embodiment will not be described in detail.

Referring to FIG. **5**, in the current embodiment, a refrigerant heating device **900** includes an auxiliary heat exchanger **910**, a heating unit **920**, a heat exchange unit **930**, a heating pipe **940**, a fluid pipe **950**, and a pump **960**. In addition, the refrigerant heating device **900** further includes a second bypass pipe **980** and a fourth valve **970**. The auxiliary heat exchanger **910**, the heating unit **920**, the heat exchange unit **930**, the heating pipe **940**, the fluid pipe **950**, and the pump **960** have similar structures as those in the second embodiment.

The pump **960** forces a working fluid to circulate through the fluid pipe **950** so that refrigerant flowing through the heating pipe **940** can exchange heat with the working fluid at the heat exchange unit **930**. At this time, some of the working fluid is bypassed to the heating unit **920** through the second bypass pipe **980**.

The fourth valve **970** is disposed at the second bypass pipe **980**. The fourth valve **970** is used to adjust heating of the refrigerant flowing through the heating pipe **940** according to the heating load of indoor areas. In more detail, the fourth valve **970** is turned on or off or the opening of the fourth valve **970** is adjusted so as to adjust the amount of working fluid bypassed through the second bypass pipe **980**. In other words, if the fourth valve **970** is turned off, the working fluid is not bypassed through the second bypass pipe **980**. If the opened area of the fourth valve **970** is increased or decreased, the amount of working fluid bypassed through the second bypass pipe **980** is increased or decreased. Therefore, at the heat exchange unit **930**, the amount of working fluid flowing through the fluid pipe **950** for changing heat with the refrigerant flowing through the heating pipe **940** can be adjusted. Accordingly, heating of the refrigerant flowing through the heating pipe **940** can be adjusted. This adjustment of the heating of the refrigerant flowing through the heating pipe **940** may be performed according to the heating load of the indoor areas.

Other elements of the air conditioning system of the current embodiment, such as an indoor heat exchanger **710** and a linear expansion valve **720** of an indoor unit **700**, an outdoor heat exchanger **810** of an outdoor unit **800**, a compressor **820**, a linear expansion valve **830**, a parallel pipe **840**, a check valve **850**, a four-way valve **860**, first to third connection pipes **851**, **873**, and **875**, first and second valves **881** and **883**, a bypass pipe **891**, and a third valve **893**, have similar structures as those of the air conditioning systems of the first and second embodiments. Thus, detailed descriptions thereof will be omitted.

As described above, according to the air conditioning system of the present disclosure, if refrigerant is heated by the refrigerant heating device in heating mode, some of refrigerant compressed by the compressor is bypassed to the outdoor heat exchanger. Therefore, owing to the refrigerant bypassed to the outdoor heat exchanger, refrigerant accumulated in the outdoor heat exchanger can be re-circulated in heat exchange cycles so that the amount of refrigerant circulating in the heat exchange cycles does not become insufficient.

Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

What is claimed is:

1. An air conditioner comprising:
- a compressor for compressing refrigerant;
- an indoor heat exchanger configured to condense refrigerant compressed by the compressor in a heating mode;
- an outdoor heat exchanger that discharges evaporated refrigerant;
- a four-way valve disposed at an outlet of the compressor to guide refrigerant to one of the indoor heat exchanger and the outdoor heat exchanger according to the heating mode and a cooling mode;
- a first pipe coupling the compressor and the four-way valve;
- a second pipe coupling the outdoor heat exchanger and the indoor heat exchanger;
- a heater;
- a third pipe coupling the second pipe and the heater;
- a fourth pipe coupling the heater and the four-way valve;
- a refrigerant heating device configured to receive the refrigerant from the indoor heat exchanger and heat the received refrigerant; and
- a bypass pipe configured to connect the first pipe to the outdoor heat exchanger, the bypass pipe guiding at least a portion of the refrigerant compressed by the compressor from the first pipe to the outdoor heat exchanger,
- wherein the third pipe allows the combined refrigerant to flow to the heater.

2. The air conditioner of claim **1**, further comprising a bypass valve at the bypass pipe that opens to allow the outdoor heat exchanger to receive at least the portion of the compressed refrigerant from the compressor.

3. The air conditioner of claim **1**,
- wherein the refrigerant discharged from the indoor heat exchanger can be combined with at least a portion of the refrigerant discharged from the outdoor heat exchanger and the combined refrigerant flows to the refrigerant heating device.

4. The air conditioner of claim **3**, further comprising a second valve at the second pipe that opens to allow at least the portion of the refrigerant to be discharged from the outdoor heat exchanger.

5. The air conditioner of claim **4**, further comprising a third valve in parallel connection with the second valve.

6. The air conditioner of claim **1**, further comprising:
- a four-way valve;
- a fourth pipe coupling the heater and the four-way valve; and
- a fifth pipe coupling the third pipe and the fourth pipe, wherein the fifth pipe allows at least a portion of the refrigerant flowing to the heater through the third pipe to be diverted to the fourth pipe.

7. The air conditioner of claim **6**, further comprising a fourth valve at the fifth pipe that opens to allow at least the portion of the refrigerant to be diverted from the third pipe to the fourth pipe.

8. The air conditioner of claim **6**, wherein the heater further comprises:
- a refrigerant heat exchanger;
- a heating element;
- a sixth pipe and a seventh pipe coupling the refrigerant heat exchanger and the heating element; and
- an eighth pipe that couples the sixth pipe and the seventh pipe, wherein the eighth pipe allows at least a portion of the refrigerant flowing to the heating element through the sixth pipe to be diverted to the seventh pipe.

9. The air conditioner of claim **8**, further comprising a fifth valve at the eighth pipe that opens to allow at least the portion of the refrigerant to be diverted from the sixth pipe to the seventh pipe.

10. The air conditioner of claim **1**, further comprising a fifth pipe coupling the refrigerant heating device and the four-way valve, wherein in the heating mode, a portion of the refrigerant compressed by the compressor flows to the outdoor heat exchanger via the bypass pipe, the refrigerant discharged by the outdoor heat exchanger flows to the refrigerant heating device via the fourth pipe, and the heated refrigerant by the heater flows to the four-way valve via the fifth pipe.

11. The air conditioner of claim **1**, further comprising:

a four-way valve;

a fifth pipe coupling the second pipe and the heater;

a sixth pipe coupling the fourth pipe and the fifth pipe, wherein the sixth pipe allows at least a portion of the refrigerant flowing to the heater through the fifth pipe to be diverted to the fourth pipe.

12. The air conditioner of claim **11**, further comprising a third valve at the fourth pipe that opens to allow at least the portion of the refrigerant to be diverted from the fifth pipe to the fourth pipe.

13. The air conditioner of claim **11**, wherein the heater further comprises:

a refrigerant heat exchanger;

a heating element;

a seventh pipe and a eighth pipe coupling the refrigerant heat exchanger and the heating element; and

a ninth pipe that couples the seventh pipe and the eighth pipe, wherein the ninth pipe allows at least a portion of the refrigerant flowing to the heating element through the seventh pipe to be diverted to the eighth pipe.

14. The air conditioner of claim **13**, further comprising a fifth valve at the ninth pipe that opens to allow at least the portion of the refrigerant to be diverted from the seventh pipe to the eighth pipe.

* * * * *